

## CLAIMS

What is claimed is:

1. A method for demodulating data from a channel, comprising:  
receiving *a priori* probability values for symbols transmitted across the channel;  
in accordance with the *a priori* probability values, determining a set of Monte Carlo samples of the symbols weighted with respect to a probability distribution of the symbols; and  
estimating *a posteriori* probability values for the symbols based on the set of Monte Carlo samples.
2. The method of claim 1, wherein:  
the *a priori* probability values are represented by  $P(s_k=a_i)$ , where the symbols in a symbol interval are represented by  $s_k$ , and  $k$  is an index identifying a transmit antenna; and  
 $a_i$  is an  $i$ th value in an alphabet set from which the symbols take their values.
3. The method of claim 1, wherein:  
the Monte Carlo samples comprise stochastic Monte Carlo samples.
4. The method of claim 1, wherein:  
the probability distribution of the symbols is represented by  $p(s | z)$ , where  $s$  is a vector of transmitted signal values for different transmit antennas in a symbol interval, and  $z$  is a vector of received signals from the different transmit antennas after nulling.
5. The method of claim 1, wherein determining the set of Monte Carlo samples of the symbols in a symbol interval, represented by  $\{(s_k^{(j)}, w_k^{(j)})\}$ , comprises:

determining a trial sampling density for each  $i$ th value,  $a_i$ , in an alphabet set  $A$  from which the symbols take their values, using the *a priori* probability value  $P(s_k=a_i)$  from a previous iteration, where the symbols are represented by  $s_k$ , and  $k$  is an index identifying a transmit antenna;

drawing the  $j$ th sample symbol  $s_k^{(j)}$ , from the alphabet set  $A$ , where  $j=1,2,\dots,m$ , and  $m$  is a number of the Monte Carlo samples determined for the symbol interval; and  
 computing an importance weight  $w_k^{(j)}$  for  $s_k^{(j)}$ .

6. The method of claim 5, further comprising:  
 performing resampling to obtain updated importance weights  $w_k^{(j)}$ .

7. The method of claim 5, further comprising:  
 initializing the importance weights  $w_{-1}(j)=1$ .

8. The method of claim 1, wherein:  
 $m$  is a number of the Monte Carlo samples determined for a symbol interval;  
 the Monte Carlo samples are represented by  $\{(s_k^{(j)}, w_k^{(j)})\}$ ,  
 each *a posteriori* probability value  $P(s_k=a_i | \mathbf{z})$  is obtained from

$$P(s_k=a_i | \mathbf{z}) = \frac{1}{W_k} \sum_{j=1}^m \mathbf{1}(s_k^{(j)} = a_i) w_k^{(j)}, a_i \in A \text{ where}$$

$\mathbf{z}$  is a vector of received signals from different transmit antennas after nulling;  
 the symbols are represented by  $s_k$ , where  $k$  is an index identifying a transmit antenna;

importance weights for the symbols  $s_k$  are represented by  $w_k$ ;

$A$  is an alphabet set from which the symbols take their values, and  $a_i$  is an  $i$ th value in  $A$ ;

$$W_k \triangleq \sum_{j=1}^m w_k^{(j)}; \text{ and}$$

1 is an indicator function defined by 
$$1(x = a) = \begin{cases} 1, & \text{if } x = a, \\ 0, & \text{if } x \neq a. \end{cases}$$

9. The method of claim 1, further comprising:  
based on the *a posteriori* probability values, calculating *a posteriori* log-likelihood ratios of interleaved code bits.

10. The method of claim 1, wherein:  
the Monte Carlo samples comprise deterministic Monte Carlo samples.

11. The method of claim 1, wherein determining the set of Monte Carlo samples of the symbols in a symbol interval, represented by  $\{(s_k^{(i)}, w_k^{(i)})\}$ , comprises:  
calculating an exact expression for the probability distribution by enumerating  $m$  samples for less than all transmit antennas to obtain  $m$  data sequences, where  $m$  is a number of the Monte Carlo samples determined for the symbol interval;  
computing the importance weight  $w_k^{(i)}$  for each symbol  $s_k^{(i)}$ , where  $k$  is an index identifying a transmit antenna; and  
selecting and preserving  $m$  distinct data sequences with the highest weights.

12. The method of claim 1, wherein:  
the channel comprises a multiple-input multiple-output (MIMO) channel.

13. A program storage device tangibly embodying a program of instructions executable by a machine to perform a method for demodulating data from a channel, the method comprising:  
receiving *a priori* probability values for symbols transmitted across the channel;

in accordance with the *a priori* probability values, determining a set of Monte Carlo samples of the symbols weighted with respect to a probability distribution of the symbols; and

estimating *a posteriori* probability values for the symbols based on the set of Monte Carlo samples.

14. A demodulator for demodulating data from a channel, comprising:  
means for receiving *a priori* probability values for symbols transmitted across the channel;

means for determining, in accordance with the *a priori* probability values, a set of Monte Carlo samples of the symbols weighted with respect to a probability distribution of the symbols; and

means for estimating *a posteriori* probability values for the symbols based on the set of Monte Carlo samples.

15. The demodulator of claim 14, wherein:  
the Monte Carlo samples comprise stochastic Monte Carlo samples.

16. The demodulator of claim 14, wherein:  
the Monte Carlo samples comprise deterministic Monte Carlo samples.

17. The demodulator of claim 14, wherein:  
the channel comprises a multiple-input multiple-output (MIMO) channel.

18. A receiver for receiving data from a channel, comprising:  
a soft outer channel decoder;  
a soft inner demodulator; and

a symbol probability computer; wherein:  
the symbol probability computer calculates *a priori* symbol probability values based on bit data received from the soft outer channel decoder; and  
the soft inner demodulator, in accordance with the *a priori* probability values, determines a set of Monte Carlo samples of the symbols weighted with respect to a probability distribution of the symbols, and estimates *a posteriori* probability values for the symbols based on the set of Monte Carlo samples.

19. The receiver of claim 18, further comprising:  
a bit log likelihood ratio computer that is responsive to the *a posteriori* probability values for determining *a posteriori* log-likelihood ratios (LLRs) of the bit data.

20. The receiver of claim 18, wherein:  
the channel from which the data is received is a multiple-input multiple-output (MIMO) channel.